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AUTHOR Ries, Wesley G.
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ABSTRACT

This unit of instruction is a survey course exploring the areas of nuclear physics, physics of modern discoveries, and their effects on the world of today. No requisites for prior course work, experience, or courses to be taken concurrently are required for enrollment. The booklet lists the relevant state-adopted texts and states the performance objectives desired. The course outline is included along with experiments and/or demonstrations, activities, and problems. Resource people are suggested, and a list of films available from the Dade County Audiovisual Center is provided. Other materials, such as transparencies and film loops, are also listed. Reference books are recommended, and a master sheet is provided relating each suggested activity to the specific performance objectives. (EB)

ED 093659

U.S. DEPARTMENT OF HEALTH
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

SE

AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

MODERN PHYSICS

5318.07

SCIENCE

(Experimental)

DADE COUNTY PUBLIC SCHOOLS

DIVISION OF INSTRUCTION • 1971

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ED 093659

MODERN PHYSICS

5318.07

SCIENCE

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Written by Wesley G. Ries
for the
DIVISION OF INSTRUCTION
Dade County Public Schools
Miami, Florida
1972

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MODERN PHYSICS

COURSE DESCRIPTION

Modern Physics is a survey course exploring the areas of nuclear physics, physics of modern discoveries and their effects on the world of today.

ENROLLMENT GUIDELINES

Electricity and Magnetism
Kinematics
Dynamics I

STATE ADOPTED TEXTBOOKS

1. Miller, Franklin; Dillon, Thomas; and Smith, Malcolm. Concepts in Physics. New York: Hartcourt, Brace, Javanovich, 1969.

2. Williams, John; Metcalfe, H. Clark; Trinklein, Frederick; and Lefler, Ralph. Modern Physics. Boston: Holt, Rinehart and Winston, 1968.

3. Rutherford, James; Holton, Gerald; and Watson, Fletcher. The Project Physics Course. Boston: Holt, Rinehart and Winston, Inc., 1970.

4. Genzer, Irwin and Yougner, Philip. The Silver Burdett Physics Program: Physics. New Jersey: Silver Burdett, 1969.

PERFORMANCE OBJECTIVES

1. Given various models of the atom, the student will cite the evidence which contributed to the development of the models.

2. Given evidence similar to Rutherford's and Bohr's, the student will be able to develop an atomic model.

3. Given a model of the atom, the student will be able to point out evidence not supported by the model.

4. The Quantum Mechanic theory will be used by the student to account for peculiarities not explainable by models.

5. The student will demonstrate evidence which supports the electron energy level theory.

6. The student will show the characteristics of the basic radiations by using magnetic fields, geiger counters and shielding.

7. The student will list the differences between natural and artificial nuclear disintegration.

8. Given the resulting isotope and its parent products, the student will estimate the particles given off and their probable characteristics.

9. The student will cite what type of detector is needed for detecting a given type of common radiation.

10. The student will show an understanding of how radiation detectors work by building one.

11. The student will make a value judgment between the value of radiation vs. the potential when used beneficially.

12. The student will describe, using diagrams and mathematics how particles are accelerated.

13. The student will cite evidence to support the existence of anti-particles.

14. Given a type of reactor, the student will describe what type reaction it is used for, what it does that others do not, and the possible beneficial use.

15. The student will cite similarities and disimilarities between the particle nature and wave nature of electrons.

PERFORMANCE OBJECTIVES (Continued)

16. Given the conditions an electron will be exposed to, the student will predict it's behavior.

17. Using electronic tubes and transistors, the student will demonstrate the value and limitation of transistors containing circuits.

18. The student will apply his knowledge of nuclear reactions to universal stellar phenomena by describing, qualitatively, these phenomena.

19. The student will give qualitative definitions of:

 a. Superconductivity
 b. Superfluidity
 c. Biophysics
 d. Solid-State Physics
 e. Laser
 F. Cryogenics

20. Given a list of physical principles, the student will give a list of benefits derived from them.

COURSE OUTLINE

I. Atomic Structure Models

 A. Rutherford nuclear atom

 B. The Bohr model and theory of the atom

 C. Discrepancies of theories

 D. Relationship to Quantum Mechanics

II. Radioactivity

 A. Nature of atoms

 1. Particulate

 2. Wave

 B. Basic radiations and their nature

COURSE OUTLINE (Continued)

C. Radioactive transformation

D. Artificial nuclear disintegration

E. Particle acceleration

F. Particle detection

1. Electronic

2. Track-forming

G. Particle stability

H. Anti-particles

I. Use of radiation

III. Nuclear Reactors

A. Fission reactions

B. Fusion reactions

C. Reactor types

D. Reactor uses

IV. Electron Effects and Uses

A. Thermal emission

B. Photoelectric effect

C. Semiconductors and transistors

D. Electron microscope

E. X-rays

F. Lasers

G. Uses of absorption and emission spectra

COURSE OUTLINE (Continued)

V. Universal Reactions

A. Solar energy

B. Cosmic energy

C. Stellar system and reactions

VI. Extreme Conditions and Reactions

A. Superfluidity

B. Superconductivity

VII. Biophysics

VIII. Effects of Physics on Modern Living

A. Benefits

B. Problems

EXPERIMENTS AND/OR DEMONSTRATIONS

Stollberg, Robert and Hill, Faith. Laboratory Investigations for Physics: Fundamentals and Frontiers. Boston. Houghton Mifflin Co., 1965.

1. The Cloud Chamber (L35)
2. Background Radiation (L37)
3. Shielding from Radiation (L40)
4. Electromagnetic Induction (L107)
5. The Wavelength of Light (L138)

Lehrman, Robert,&Swartz, Clifford. Foundations of Physics and Laboratory Experiments. New York: Holt, Rinehart and Winston, Inc., 1969.

6. The Size of a Molecule (p. 151)
7. Electromagnetic Induction (p. 220)
8. Solid State Diode (p. 235)
9. Micro-wave (p. 245)
10. Wavelength (p. 246)
11. Photometry (p. 257)

EXPERIMENTS AND/OR DEMONSTRATIONS (Continued)

12. Polarization of Light (p. 261)
13. The Electron (p. 276)
14. Quantum Optics (p. 267)
15. Atomic and Molecular Systems (p. 286)
16. The Geiger-Muller Counter (p. 303)
17. Intensity of Gamma Radiation from a Paint Source (p. 304)
18. Half-life Of a Radioactive Element (p. 304)
19. Analysis of Particle Tracks (p. 305)
20. The Universe (p. 310)

Bio-Atomic Research Foundation. Radioisotopes and Inquiry. Chicago: Encyclopaedia Britannica Educational Corporation, 1968.

21. Techniques of Autoradiography (p. 1)
22. Half-life and Radioisotope Identification (p. 11)
23. Distance and Intensity (p. 17)
24. Radioisotopes as a Tool (p. 21)
25. Rate of Diffusion Through a Membrane (p. 26)
26. Transport of Phosphates in Plants (p. 331)
27. A Comparison of the Re-distribution of Calcium and Phosphorus in Plants (p. 38)
28. Effect of Light on the Uptake of Phosphorus by Plants (p. 47)
29. Uptake and Utilization of $C^{14}O_2$ During Photosynthesis (p. 51)
30. Colors of Light and Photosynthetic Efficiency (p. 61)
31. Incorporation of Phosphorus by Fish (p. 69)
32. Distribution of Phosphorus in the Frog (p. 73)
33. Distribution of Phosphorus in the Rat (p. 77)
34. Uptake and Utilization of P^{32} in the Development of Hen's Eggs (p. 82)
35. Growth and Chemical Activity in Roots (p. 88)
36. Carbon Utilization by Bacteria (p. 94)
37. Area Production in a Mammal (p. 103)
38. Effect of Ultraviolet Radiation on Bacteria (p. 111)
39. Ultraviolet Radiation and Photoreactivation (p. 115)
40. The Effect of an Antibiotic on Nuclear Acid Synthesis in Micro-organisms (p. 122)

Sutton, Richard Manliffe. Demonstration Experiments in Physics. New York: McGraw-Hill Book Company, Inc., 1968.

41. Kelvin Water Dropper, E-25 (p. 261)
42. Speed of Light, L-17 (p. 376)
43. Ionization in Air, A-1 (p. 431)
44. Ion Mobilities, A-3 (p. 432)
45. Singing Arc, A-10 (p. 436)
46. Glow Discharge, A-12 (p. 438)
47. Electron Beams, A-18 (p. 441)

EXPERIMENTS AND/OR DEMONSTRATIONS (Continued)

48. Magnetic Deflection of Cathode Ray, A-20 (p. 443)
49. Order of Magnitude of Molecular Dimensions, A-52, 53 (p. 465)
50. Alpha-particle Scattering-Electrostatic Model, A-63 (p. 472)
51. Alpha-particle Scattering-Electrostatic Model, A-64 (p. 473)
52. Nuclear-disintegration Model, A-65 (p. 473)
53. Ionization and Radiation Potentials, A-67 (p. 474)
54. Emission Spectra-Balmer Series, A-69 (p. 476)
55. Measurement of e.m, A-72 (p. 477)
56. Thermionic Effect in Air, A-77 (p. 480)
57. Surface Photoelectric Effect, A-89 (p. 488)
58. Discovery of Photoelectric Effect, A-90 (p. 489)
59. Photoelectric Threshold, A-92 (p. 489)
60. Velocity of Photoelectrons, A-93 (p. 490)
61. Photoelectric Relays, A-97 (p. 491)
62. Transmission of Sound by Light, A-99 (p. 493)
63. Absorption Coefficients, A-107 (p. 499)
64. X-ray Diffraction, A-108 (p. 500)
65. X-ray and Electron Diffraction Model, A-109 (p. 500)
66. Sources of Radioactivity, A-111 (p. 501)
67. Electroscope Experiments, A-112 (p. 502)
68. Range of Alpha Particles, A-113 (p. 502)
69. Scattering of Alpha Particles, A-114 (p. 502)
70. Radioactive Decay, A-115 (p. 503)
71. Wilson Cloud Chamber, A-116 (p. 503)
72. Geiger-Muller Tube Counter, A-108 (p. 304)
73. Water-jet Counter, A-120 (p. 507)

Physical Science Study Committee. Laboratory Guide: Physics. Massachusetts: D. C. Heath Company, 1965.

74. The Millikan Experiment (p. 69)
75. The Mass of the Electron (p. 79)
76. Randomness in Radioactive Decay (p. 83)
77. The Spectrum of Hydrogen and Planck's Constant (p. 84)

Rutherford, James, et al. The Project Physics Course Handbook. Boston: Holt, Rinehart and Winston Inc., 1970.

78. Electron Beam Tube (p. 255)
79. Waves and Communication
 c. Elementary Properties of Microwaves (p. 271)
 d. Interference of Reflected Microwaves (p. 272)
 e. Signals and Microwaves (p. 274)

EXPERIMENTS AND/OR DEMONSTRATIONS (Continued)

80. The Charge-to-mass Ratio for an Electron (p. 289)
81. The Measurement of Elementary Charge (p. 292)
82. The Photoelectric Effect (p. 295)
83. Spectroscopy (p. 302)
84. Random Events (p. 316)
85. Range of A (alpha) and B (beta) Particles (p. 321)
86. Half-life (p. 324)
87. Radioactive Tracers (p. 328)
88. Radioactive Tracers (p. 330)
 A. Autoradiography (p. 332)
 B. Chemical Reactions and Separations (p. 332)

Williams, John et al. Laboratory Experiments in Physics. New York: Holt, Rinehart and Winston Inc., 1968.

89. The Size of a Molecule (p. 35)
90. Radioactivity (p. 37)
91. Half-life (p. 38)
92. Wave Properties (p. 52)
93. Photometry (p. 60)
94. The Polarization of Light (p. 88)
95. Thermionic Emission (p. 126)
96. Diode Characteristics (p. 128)
97. Triode Characteristics (p. 130)

Dillon, Thomas, et al. Concepts in Physics Laboratory Manual. New York: Harcourt, Brace and World Inc., 1969.

98. Electric Charges (p. 49)
99. Reversible and Irreversible Energy Transfers in an Electric Circuit (p. 58)
100. Passive Circuit Elements - The Diode (p. 76)
101. The Transistor and Amplification (p. 78)
102. Interference of Light (p. 88)
103. The Thermistor - A Semiconductor Device (p. 93)
104. The Solid State - Cooling and Freezing of an Alloy (p. 95)
105. Mass of the Electron (p. 97)
106. The Oscilloscope (p. 101)
107. The Neon Bulb Oscillator (p. 104)

Genzer, Irvin, et al. Laboratory Investigations in Physics. New Jersey: Silver Burdett Company, 1969.

108. Relative Velocity (p. 41)
109. Electron Discovered (p. 61)
110. Magnetic Effects Associated with Electricity (p. 77)
111. Electricity - A Form of Energy (p. 139)

EXPERIMENTS AND/OR DEMONSTRATIONS (Continued)

112. The Charge of an Electron (p. 143)
113. The Mass of an Atom (p. 149)
114. A Particle Model for Light (p. 193)
115. A Wave-Something Else that Moves (p. 187)

Physical Science Study Committee. Physics: Advanced Topics Supplement. Boston: D. C. Heath And Company, 1966.

116. An "Ether" Experiment (p. 164)
117. The Spectrum of Hydrogen and Planck's Constant (p. 165)
118. The Spectrum of Hellum (p. 168)

Alyea, Hubert and Dutton, Frederic. Tested Demonstrations in Chemistry. Easton, Pennsylvania: Journal of Chemical Education, 1960.

119. Isotopes (p. 21)
120. Radioactivity (p. 21)
121. Artificial Transmutation (p. 22)
122. Planetary Phenomena (p. 22)

ACTIVITIES

Rutherford, James et al. The Project Physics Course Handbook. Boston: Holt, Rinehart and Winston, Inc., 1970.

1. Polorized Light (p. 240)
2. Measuring Magnetic Field Intensity (p. 258)
3. Additional Activities Using the Electron Beam Tube (p. 260)
4. Microwave Transmission Systems (p. 275)
5. Writings by or About Einstein (p. 299)
6. Measuring Q/M for the Electron (p. 299)
7. Cathode Rays in a Crookes Tube (p. 299)
8. X-rays From a Crookes Tube (p. 299)
9. Measuring Ionization, a Quantum Effect (p. 305)
10. Modeling Atoms With Magnets (p. 305)
11. "Black Box" Atoms (p. 307)
12. Another Simulation of the Rutherford Atom (p. 308)
13. Turntable Oscillator Patterns Resembling De Broglie Waves (p. 310)
14. Magnetic Deflection of B (beta) Rays (p. 334)
15. Measuring the Energy of B (beta) Radiation (p. 334)
16. A Sweet Demonstration (p. 336)
17. Ionization by Radioactivity (p. 336)
18. Exponential Decay in Concentration (p. 336)
19. Neutron Detection Problem Analogue (Chadivich's Problem) (p. 337)

ACTIVITIES (Continued)

20. Two Models of a Chain Reaction (p. 339)
21. More Information on Nuclear Fission and Fusion (p. 339)
22. Peaceful Uses of Radioactivity (p. 339)

RESOURCE PEOPLE

1. X-ray Technicians
2. Hospital Radiologist
3. Miami Dade Junior College
4. Civil Defense Organization

PROBLEMS

Catska, Joseph; Lefler, Ralph. Physics Problems. New York: Holt, Rinehart and Winston, Inc., 1961.

1. Atomic Structure (p. 107)
2. Radioactivity and Nuclear Energy (p. 117)
3. Electronics (p. 341)
4. Nuclear Physics (p. 378)
5. General Topics in Modern Physics (p. 379)
6. Light (p. 379)
7. Modern Physics (p. 393)

DADE COUNTY 16 mm FILMS

1. "A" Is for Atom
 I-10790, 16', C

2. Sun's Energy
 I-10649, 17', C

3. Atom and Biological Science
 I-03550, 12', B/W

4. Atom Goes to Sea
 I-01924, 12', B/W

DADE COUNTY 16 mm FILMS (Continued)

5. Atom Smashers
I-01923, 12.5', B/W

6. Atom Smashers
I-01922, 12', B/W

7. Atomic Energy
I-01940, 10', B/W

8. Atomic Energy: Inside the Atom
I-10786, 14', C

9. Atomic Power
I-10918, 19', B/W

10. Atomic Radiation
I-01921, 11', B/W

11. Atomic Research: Areas and Development
I-10788, 13', B/W

12. Cosmic Rays
I-30330, 30', B/W

13. Counting Electrical Charges in Motion
I-10755, 20', B/W

14. Diode: Principals and Application
I-12988, 17', B/W

15. Discovery of Radium
I-30346, 29', C

16. Electromagnetic Cathode Ray Tube, Theory of Operation
I-31317, 20', B/W

17. Electron: An Introduction
I-12998, 16', B/W

18. Electrons
I-03541, 11', B/W

19. Electrons at Work
I-10763, 14', B/W

20. Explaining Matter: Atoms and Molecules
I-10777, 13', C

DADE COUNTY 16 mm FILMS (Continued)

21. Fundamentals of Radiac Instruments
1-31326, 25', B/W

22. Introducing Atoms and Nuclear Energy
1-01920, 11', C

23. Jobs in Atomic Energy
1-01927, 12', B/W

24. Mass of the Electron
1-10763, 18', B/W

25. Molecular Spectroscopy
1-10869, 22', C

26. Molecular Theory of Matter
1-01945, 11', B/W

27. Nature of Energy
1-01733, 10', B/W

28. Nuclear Radiation: Detectors
1-10798, 15', C

29. Nuclear Radiation in Outer Space
1-11423, 17', C

30. Our Friend the Atom Part I, Part II
1-30333 and 1-30335, 50', C each

31. Principals of Nuclear Fission
1-10797, 20', C

32. Rutherford Atom
1-40022, 25', B/W

33. Strange Case of the Cosmic Rays Part I and II
1-30243 and 1-30246, 30', C each

34. Transistors in Pulse Applications
1-40113, 29', B/W

35. Transistors: Low Frequency Amplifiers
1-13168, 15', B/W

DADE COUNTY 16 mm FILMS (Continued)

36. Trapping of Free Radicals at Low Temperatures
1-10936, 13.5', C

37. Triods: Amplification
1-13171, 14', B/W

38. Unlocking the Atom
1-10787, 19', B/W

39. Work Energy and Power
1-10665, 23', B/W

40. You Can Beat the A-Bomb
1-13186, 20', B/W

DADE COUNTY TRANSPARENCIES

1. Atomic Energy
2-30022, C

2. Atomic Structure
2-00085, B/W

DADE COUNTY SLIDES

1. Atomic Energy
5-20076, C

DADE COUNTY SINGLE CONCEPT FILM

1. Nuclear Radiation Series
7-30011, 20', C, 5 films (8 min. silent)

SPECIAL INSTRUCTIONS

1. A variety of experiments are suggested at various levels of sophistication. The teacher should choose those labs which are best adapted to their student's ability levels, time schedules, and available facilities. Many experiments may be used as demonstrations and vice-versa.

2. This course as written does not mandate the curriculum. It may be adapted to a variety of teaching strategies:

 a. A self-pacing, individualized learning approach

 b. Small group seminar-research type approach

 c. A structured situation in which all students participate in the same activities.

3. The reference list is neither a "must" nor complete but only suggested and should be used as a basis for further development of your own reference list.

4. Included in all the listed references and textbooks are related problems, discussion questions, activities, and project ideas too numerous to list but readily visible when using them.

REFERENCES

1. Atkins, K. R. Physics. New York: John Wiley and Sons, Inc., 1965.

2. Ference, Michael; Leman, Harvey and Stephenson, Reginald. Analytical Experimental Physics. Chicago: University of Chicago Press, 1958.

3. Glasstone, Samuel. Sourcebook on Atomic Energy. New York: D. Van Nostrand Company, Inc., 1958.

4. Haber-Schaim, Uri; Cross, Judson B.; Dodge, John H.; Walter, James A. PSSC Physics. Massachusetts: D. C. Heath and Company, 1971.

5. Heckman, Harry H. and Starring Paul W. Nuclear Physics and the Fundamental Particles. New York: Holt, Rinehart and Winston, Inc., 1963.

6. Holden, Alan. Conductors and Semiconductors. New York: Bell Telephone Laboratories, 1964.

REFERENCES (Continued)

7. Lehrman, Robert and Swartz, Clifford. Foundations of Physics. New York: Holt, Rinehart and Winston, Inc., 1969.

8. Marantz, Samuel, Physics. New York: Benziger Brothers, 1969.

9. Physical Science Study Committee. Physics Advanced Topics Supplement. Boston: D. C. Heath and Company, 1966.

10. RCA Service Company. Atomic Radiation. New Jersey: RCA Service Company, a Division of Radio Corporation of America, Government Service Department, 1959.

11. Sears,Francis Weston. Mechanics, Wave Motion, and Heat. Reading, Massachusetts: Addison-Wesley, Inc., 1960.

12. Sears, F. W. and Semansky, M. W. University Physics. Reading, Massachusetts: Addison-Wesley Publishing Co., Inc., 1960.

13. Stollberg, Robert and Hill, Faith. Physics Fundamentals and Frontiers. Boston: Houghton Mifflin Company, 1965.

14. Wehr, Russell M. and Richards, James A. Jr., Physics of the Atom. Reading, Massachusetts: Addison-Wesley Publishing Co., Inc., 1960.

MASTER SHEET--MODERN PHYSICS

Objective	State Adopted Textbooks	References	Demonstrations and/or Experiments	Films	Activities	Problems	Trans-parencies	Slides	Single Concept Film
1	#1. chap. 24, 25 #2. chap. 11 #3. chap. 17, 18,19 #4. chap. 14, 24	#1. chap. 30	6,15,43,44,45 46,47,48,49,50, 51,74,75,77,80, 81,89,106,112, 113,122	20,24,25,26, 30	2,10,11,12	1	2		
2	#1. chap. 24, 25 #2. chap. 11 #3. chap. 17, 18,19 #4. chap. 14, 24	#1. chap. 30 #2. chap. 38 #3. chap. 4, 13,9 #4. chap. 24 #5. chap. 1,3 #6. chap. 2,3 #7. chap. 21 #8. chap. 20 #12. pp. 530-532,580-582,588 681-690	6,15,43,44,45, 46,47,48,49,50, 51,74,75,77,80, 81,89,106,112, 113,122	20,24,25,26, 30,32	2,10,11,12	1	2		
3	#1. chap. 24, 25 #2. chap. 11 #3. chap. 17, 18,19 #4. chap. 14, 24	#1. chap. 30 #2. chap. 38 #3. chap. 4,5, 6,7,8,9, 10,11,14, 18 #4. chap. 24 #5. chap. 1,3 #6. chap. 2,3 #7. chap. 21 #8. chap. 20 #12. pp. 961, 984 #13. chap. 5 #14. chap. 1, 4	6,15,43,44,45, 46,47,48,49, 50,51,74,75, 77,80,81,89, 106,112,113, 122	20,24,25,26, 30	2,10,11,12	1	2		
4	#1. chap. 24, 25 #2. chap. 11 #3. chap. 18 #4. chap. 24, 25	#1. chap. 26, 27,28 #2. chap. 37 #3. chap. 3,4, 12,9 #4. chap. 26, 27 #5. chap. 1 #7. chap. 19, 20 #8. chap. 19, 20 #9. chap. 5,6 #12. p. 967 #13. chap. 23, 27 #14. chap. 7	5,9,10,14,42, 92,102,114, 115,108,116	17,27	4,5,9,13	2			

Objectives	State Adopted Textbooks	References	Demonstrations and/or Experiments	Films	Activities	Problems	Trans-parencies	Slides	Single Concept Films
5	#1. chap. 25 #2. chap. 11 #3. chap. 17, 18,19 #4. chap. 14, 24	#1. chap. 29, 33 #2. chap. 38 #3. chap. 1,3, 4,9 #4. chap. 26 #5. chap. 1 #6. chap. 2,3 #7. chap. 19, 20,21 #8. chap. 19, 20 #9. chap. 6 #12. pp. 952-959,681-688,804 #14. pp. 90-93,106, 45	4,7,13,43,44, 45,46,47,48,49, 54-61,64,65,74, 75,77,80,81, 109,117,118	1,13,16,17, 18,19,27	3,7	1	2		
6	#1. chap. 25 #2. chap. 12 #3. chap. 21 #4. chap. 24, 25	#1. chap. 32 #2. chap. 38 #3. chap. 5, 6,7 #5. chap. 2, 4,7,8 #7. chap. 22 #8. chap. 21 #9. chap. 7 #10. pp. 6-35 #12. chap. 44 #13. chap. 6 #14. pp. 235-237	2,3,16,17,18, 19,22,23,53, 63,68,69,70, 76,85,90,120	10,12,15,22, 28,33	2,3.7, 14-19	2	1	1	1
7	#1. chap. 25 #2. chap. 12 #3. chap. 22 #4. chap. 24, 25	#1. chap. 32 #2. chap. 38 #3. chap. 10 #5. chap. 2,3, 4,5,7,8 #7. chap. 22 #8. chap. 21 #9. chap. 7 #12. pp. 988, 992	52,70,84,86, 91,121		5,6,8	2	1	1	1
8	#1. chap. 25 #2. chap. 12 #3. chap. 22 #4. chap. 24, 25	#1. chap. 32 #2. chap. 38 #3. chap. 8 #5. chap. 2,4, 7,8 #7. chap. 22 #8. chap. 21 #9. chap. 7 #10. pp. 17-28 #12. p. 988 #13. chap. 6 #14. p. 444	22,24,52,66, 70,91,119	5,6,8		2	1	1	1
9	#1. chap. 25 #2. chap. 12, 26 #3. chap. 21 #4. chap. 24, 25	#1. chap. 32 #2. chap. 38 #3. chap. 5,6, 7 #5. chap. 4,7, 8 #7. chap. 22 #8. chap. 21 #10. pp. 61-78 #13. chap. 6 #14. pp. 238-255	2,16,17,18, 19,53,66,68, 69,70,71,72, 73	10,28	2,14-19	2	1	1	1

Objectives	State Adopted Textbooks	References	Demonstrations and/or Experiments	Films	Activities	Problems	Transparencies	Slides	Single Concept Films
10	#2. chap. 26	#2. p. 587 #11. pp. 567-568 #14. pp. 241-245	1,19,71,72,73,67						
11	#2. chap. 17 #3. chap. 20 #4. chap. 24, 25	#1. chap. 31 #3. chap. 17 #7. chap. 22 #8. chap. 21 #10. pp. 43-57 #14. pp. 266-268	21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,40,87,88		5	5,7	1	1	
12	#1. chap. 25 #2. chap. 26 #3. chap. 9 #4. chap. 25, 55	#1. chap. 32 #2. chap. 38 #3. chap. 9 #4. chap. 18 #5. chap. 4 #6. chap. 6,9 #7. chap. 22 #12. pp. 739-743,688, 983,992-994 #14. chap. 12		5,6,33	2	2			
13	#2. chap. 26 #3. chap. 18 #4. chap. 25	#1. chap. 32, 33 #2. chap. 38 #3. chap. 18 #5. chap. 6,9, 10,11 #7. chap. 22 #12. pp. 739-743,688, 830,992-994,983 #14. chap. 12		33		2			
14	#1. chap. 25 #2. chap. 12 #3. chap. 24 #4. chap. 25	#1. chap. 31 #2. chap. 38 #3. chap. 15 #5. chap. 5 #7. chap. 22 #9. chap. 7 #10. pp. 35-41 #12. pp. 997-1001 #13. chap. 6 #14. chap. 11	52,70	3,5,6,7, 8,9,31, 38,39	20,21,22	2,4	1	1	
15	#1. chap. 24 #2. chap. 11, 15 #3. chap. 18 #4. chap. 25	#1. chap. 29 #2. chap. 38 #3. chap. 2,3, 4,5 #4. chap. 27 #5. chap. 1 #7. chap. 22 #8. chap. 19 #9. chap. 6 #13. chap. 5 #14. chap. 7	10,42,80,81, 92,102,114, 115,108	17,24,27	5,13	1			

Objectives	State Adopted Textbooks	References	Demonstrations and/or Experiments	Films	Activities	Problems	Transparencies	Slides	Single Concept Films
16	#1. pp. 423-437 #2. chap. 25 #3. chap. 24 #4. chap. 22	#1. chap. 16 #2. chap. 38 #3. chap. 9 #4. chap. 18, 19,20 #6. chap. 3,4 #7. chap. 20 #12. pp. 640, 672,681-690,698 #13. chap. 21, 22 #14. chap. 2,3	7,11,13,41,43, 54061,64,65, 66,67,74,75, 78,79,80,81, 82,83,95,96, 97,98,106, 107,109	13,16,18,19	3,6,7,8	1,3,5			
17	#1. pp. 330-337 #2. chap. 25 #3. chap. 24 #4. chap. 22	#2. chap. 30, 37,38 #4. chap. 21 #6. chap. 5,6, 7,8, #8. chap. 18 #13. chap. 21, 22 #14. pp. 45, 54,66, 72-77	8,9,10,11,64, 65,78,79,82, 83,95,96,97, 98,99,100, 101,103,106, 107,110	13,14,18, 19,21,34, 35,37	8	6,7,3,5			
18	#2. chap. 27 #3. chap. 20, 24 #4. chap. 24, 25	#2. chap. 38 #5. chap. 2, 12 #7. chap. 23 #13. chap. 27 #14. pp. 279, 301,338	20	2,12,29	21	6,7,5,7			
19	#1. p. 436 chap. 25 #2. chap. 27 #3. chap. 20 #4. chap. 23, 25	#1. chap. 33 #6. chap. 5, 6,7,8 #7. chap. 23 #8 chap. 21 #12. chap. 43, 44 #13. chap. 23, 27 #14. pp. 216-232	11,12,62,93, 94,101,103, 104	36	1,4,8	5,7			
20	#2. chap. 27 #3. chap. 20 #4. chap. 23, 25	#1. chap. 33 #2. chap. 38 #3. chap. 19 #4. chap. 12 #8. chap. 21 #10. chap. 2, 3,4,5 #12. chap. 43, 44 #13. chap. 23, 27	21,22,24,25, 26,27,28,29, 30,34,35,36, 37,38,39,40, 82,87,88,110, 111	3,4,11,23, 40	8,22		1	1	